The hub 162 of the outer tube 160 preferably has a larger diameter than the tubular member 164 does. The hub 162 has a pair of outer tube holes 161 to receive pin 163 to allow the hub 162 to be coupled to rotational knob 190. As a result, the outer tube 160 will rotate when the rotational knob 190 is turned or rotated.

The hub 162 of the outer tube 160 also includes wrench flats 169 on opposite sides of the hub 162. The wrench flats 169 are preferably formed near the distal end of the hub 162. The wrench flats 169 allow torque to be applied by a torque wrench to the hub 162 to tighten the ultrasonic waveguide 179 to the stud 50 of the acoustic assembly 80. For example, U.S. Patent Nos. 5,059,210 and 5,057,119, which are hereby incorporated herein by reference, disclose torque wrenches for attaching and detaching a transmission component to a mounting device of a hand piece assembly.

Located at the distal end of the tubular member 164 of the outer tube 160 is an end-effector 180 for performing various tasks, such as, for example, grasping tissue, cutting tissue and the like. It is contemplated that the end-effector 180 may be formed in any suitable configuration.

End-effector 180 and its components are shown in greater detail in Figures 23 through 33. The end-effector 180 generally includes a non-vibrating clamp arm assembly 300 to, for example, grip tissue or compress tissue against the ultrasonic blade 88. The end-effector 180 is illustrated in Figures 23 and 26 in a clamp open position, and clamp arm assembly 300 is preferably pivotally attached to the distal end of the outer tube 160. Ultrasonic vibrations are transmitted along the ultrasonic waveguide 179 in a longitudinal direction to vibrate the ultrasonic blade 88.

Looking first to Figures 23 through 26, the clamp arm assembly 300 preferably includes a clamp arm 202, a jaw aperture 204, a first post 206A and a second post 206B, and a tissue pad 208. The clamp arm 202 is pivotally mounted

about pivot pins 207A and 207B to rotate in the direction of arrow 122 in Figure 3 when thumb loop 142 is moved in the direction indicated by arrow 121 in Figure 3. By advancing the pivoting handle portion 136 toward the instrument housing 130, the clamp arm 202 is pivoted about the pivot pin 207 into a closed position. Retracting the pivoting handle portion 136 away from the instrument housing 130 pivots the clamp arm 202 into an open position.

The clamp arm 202 has tissue pad 208 attached thereto for squeezing tissue between the ultrasonic blade 88 and clamp arm assembly 300. The tissue pad 208 is preferably formed of a polymeric or other compliant material and engages the ultrasonic blade 88 when the clamp arm 202 is in its closed position. Preferably, the tissue pad 208 is formed of a material having a low coefficient of friction but which has substantial rigidity to provide tissue-grasping capability, such as, for example, TEFLON, a trademark name of E. I. Du Pont de Nemours and Company for the polymer polytetraflouroethylene (PTFE). The tissue pad 208 may be mounted to the clamp arm 202 by an adhesive, or preferably by a mechanical fastening arrangement as will be described below.

As illustrated in Figures 23, 26 and 28, serrations 210 are formed in the clamping surfaces of the tissue pad 208 and extend perpendicular to the axis of the ultrasonic blade 88 to allow tissue to be grasped, manipulated, coagulated and cut without slipping between the clamp arm 202 and the ultrasonic blade 88.

Tissue pad 208 is illustrated in greater detail in Figures 27 through 29. Tissue pad 208 includes a T-shaped protrusion 212, a left protrusion surface 214, a right protrusion surface 216, a top surface 218, and a bottom surface 219. Bottom surface 219 includes the serrations 210 previously described. Tissue pad 208 also includes a beveled front end 209 to ease insertion during assembly as will be described below.

Referring now to Figure 26, the distal end of the tubular member 174 of the inner tube 170 preferably includes a finger or flange 171 that extends therefrom. The flange 171 has openings 173A and 173B (opening 173B not

shown) to receive the post 206 of the clamp arm 202. When the inner tube 170 of the elongated member 150 is moved axially, the flange 171 moves forwardly or rearwardly while engaging the post 206 of the clamp arm assembly 300 to open and close the clamp arm 202.

Referring now to Figures 24, 25, and 31 through 33, the clamp arm 202 of end-effector 180 is shown in greater detail. Clamp arm 202 includes an arm top 228 and an arm bottom 230, as well as a straight portion 235 and a curved portion 236. Straight portion 235 includes a straight T-slot 226. Curved portion 236 includes a first top hole 231, a second top hole 232, a third top hole 233, a fourth top hole 234, a first bottom cut-out 241, a second bottom cut-out 242, a third bottom cut-out 243, a forth bottom cut-out 244, a first ledge or engaging surface 221, a second engaging surface 222, a third engaging surface 223, a fourth engaging surface 224, and a fifth engaging surface 225.

Top hole 231 extends from arm top 228 through clamp arm 202 to second engaging surface 222. Top hole 232 extends from arm top 228 through clamp arm 202 to third engaging surface 223. Top hole 233 extends from arm top 228 through clamp arm 202 to fourth engaging surface 224. Top hole 234 extends from arm top 228 through clamp arm 202 to fifth engaging surface 225.

Holes 231 through 234 are staggered laterally from proximal top hole 232 to distal top hole 234. Likewise, engaging surfaces 221 through 225 are staggered laterally from proximal engaging surface 221 to distal engaging surface 225. Hole 231 is arranged to terminate at engaging surface 222, hole 232 is arranged to terminate at engaging surface 223, hole 233 is arranged to terminate at engaging surface 224, and hole 234 is arranged to terminate at engaging surface 225. The arrangement of holes 231 through 234 and engaging surfaces 221 through 225 enables clamp arm 202 to include both the straight portion 235 and the curved portion 236, while being moldable from a process such as, for example, metal injection molding (MIM). Clamp arm 202 may be made out of stainless steel or other suitable metal utilizing the MIM process.